

How to Use These Units

These three units of study were developed to teach specific concepts in the core content for science, social studies and practical living. In addition, students will use math skills, do a great deal of reading and writing, express themselves artistically, and use the Internet and other technology to gather information. The units are divided into K-3, 4-5 and 6-9 grade levels, but published together so that teachers can choose additional activities that they think are appropriate to particular children or classes. The units do build on each other but can also stand alone. There are at least eleven activities in each unit and many teachers may choose to do only some of the activities. If so, you are urged to make sure that you do enough activities to cover each core content bullet in the unit. This insures that students get a strong knowledge base about solid waste.

While the activities in the units teach basic concepts, nearly every activity uses instructional strategies that are inquiry-based and authentic. In these exercises, teachers become facilitators and resource people while students pose the questions and find the answers. Since these kinds of lessons can be time consuming for teachers to put together, the units contain such supports as model letters to parents, sources of further information, examples of worksheets, and, perhaps most importantly, a whole section of teacher fact sheets. The teacher fact sheets, taken directly from EPA's "Quest for Less" unit, provide one-stop-shopping for teachers who want to become a little more expert in issues of solid waste as they conduct the unit.

Each unit begins with an overview. In this overview you will find a description of each activity, the standards taught by that activity, and the essential and guiding questions that teachers can use to help students focus on the right information. All three units are titled "Be a Solid Waste Survivor" but each has a slightly different focus.

- In the Primary Unit, students "Take the Community Challenge" and learn about solid waste issues and how those issues play out in their own families and communities. In the culminating activity of the unit, students make concept vests and use them to teach their own families about solid waste issues.
- In the Intermediate Unit, students "Take the Consumer Challenge" and begin to see how their own actions as consumers can affect solid waste issues. The culminating event in their unit is an enviro-fair where they make, advertise and buy environmentally friendly products.
- Finally, in the Middle Grades Unit, students "Take the Citizenship Challenge" and learn how they, and other citizens, affect solid waste issues. In their culminating event, they actually plan and implement a community service project that addresses local solid waste problems.
- A high school unit, Waste, A Hidden Resource in Kentucky, is already available through the Kentucky Division of Waste Management.

We hope you and your students enjoy the unit. If you have questions or need more information, please feel free to contact the Kentucky Environmental Education Council at 800/882-5271.

Teacher Fact Sheets

Teacher Fact Sheet

Solid Waste

What is Solid Waste?

Young or old, everyone produces solid waste (otherwise known as trash), whether it is old newspapers, potato chip bags, shampoo bottles, cut grass, food scraps from the dinner table, old appliances, or even the kitchen sink. Each person in the United States generates about 4.5 pounds (EPA, 1998) of solid waste each day, which is often collected by a municipality and is known as municipal solid waste. This kind of waste primarily comes from people's homes, but it also comes from some factories, businesses, and schools.

As our population has grown, so has the number of products we use and the total amount of solid waste we generate. Consequently, the composition of garbage continues to change with more plastics, more office paper, and less glass filling up trash cans around the country.

How do we Manage Solid Waste?

No single method can manage all our nation's garbage. The U. S. Environmental Protection Agency (EPA) recommends the use of a waste management hierarchy, which ranks methods of waste management in order of preference. Although mentioned briefly here, each method is explained in separate fact sheets. Please refer to these other fact sheets for more information regarding the benefits, challenges, trends, and opportunities of each waste management system. EPA's waste management hierarchy includes:

- **Source Reduction:** Source Reduction, also known as waste prevention, is the preferred method of waste management because the best way to manage garbage is to prevent it in the first place. As the name implies, this method prevents waste at the source by decreasing consumption and reusing products. It also includes using nonhazardous substitutes to reduce the level of toxicity in the waste stream. For example, using a durable cloth lunch bag or reusing the same brown paper bag instead of a new brown paper bag each day prevents waste, or using baking soda to clean kitchen and bathroom counters rather than a chemical detergent prevents the disposal of toxins.
- **Recycling including Composting:** If waste cannot be prevented, the next best way to reduce it is to recycle or compost it. Recycling refers to a series of activities where discarded materials are collected, sorted, processed, converted into raw materials, and used to make new products. Composting is the decomposition of organic materials such as yard trimmings and food scraps by microorganisms. The byproduct of this process is compost—a soil-like material rich in nitrogen and carbon that can be used as a plant fertilizer supplement. Both of these processes use waste as a raw material to create new and valuable products.
- **Disposal: Combustion and Landfills.** Trash that cannot be reduced, recycled, or composted must be disposed of. Combustion is the burning of waste in specially designed facilities provide the added benefit of energy recovery (waste to energy facilities). Source reduction and recycling can remove items from the waste stream that might be difficult to burn, cause potentially harmful emissions, or make ash management problematic. Landfills are also major components of waste management. A landfill is a large area of land or an excavated site that receives waste. Combustion facilities and landfills are subject to environmental controls that require them to be properly maintained so there is no waste runoff that might contaminate drinking water supplies. The portion of waste requiring combustion and land disposal can be significantly reduced by examining individual contributions to garbage and by promoting the wise use and reuse of resources.

Key Points

- Americans generate about 4.5 pounds of garbage per person each day, which amounts to more than 220 million tons per year.
- EPA advocates a solid waste hierarchy, organizing waste management options in order of preference: source reduction, recycling, and composting, and combustion and landfilling.
- Facing a variety of challenges from rising waste generation rates and costs to closing disposal facilities—community leaders and businesses are devising ways to prevent waste and increase efficiency.

What are the Benefits of Waste Management?

It might seem hard to believe now, but people once dumped trash out windows onto the streets, left it in local ravines or quarries, or burned it in fields and open dumps. In fact, throughout time, people have made garbage “go away” in different ways, regardless of environmental or aesthetic impacts. As one can imagine, these activities created serious sanitation problems for a community. Open dumps produced noxious odors, attracted rodents and pests that spread disease, and polluted drinking water supplies.

Federal, state, and local laws now control how solid waste is managed and disposed of. These regulations set standards for trash disposal. As a result of regulations, many communities have state-of-the-art landfills and combustion facilities that minimize ground and surface water contamination and air pollution. At the same time, they provide a safe and convenient way to remove trash from homes and neighborhoods.

Waste management can also create jobs and provide an economic boost to some cities and counties. Whether workers are collecting garbage, constructing disposal facilities, managing recycling programs, or developing new technologies, the waste management industry employs hundreds of thousands of people nationwide.

Solid Waste Facts

- Each year, Americans discard more than 8 million old or broken appliances such as clothes dryers, refrigerators, and televisions.
- One third of all the garbage discarded by Americans is packaging.
- The average home may have up to 100 pounds of household hazardous waste stored throughout the house.
- Americans generate 1.6 million tons of household hazardous waste each year.

(Sources: Keep America Beautiful; Natural Resources Defense Council, 1996, EPA)

What are the Challenges of Solid Waste Management?

Despite the improvements that have been made to solid waste landfills and combustion facilities over the years, the general public still does not want to live near a disposal facility. With varying public opinion and the Not in My Backyard (NIMBY) mentality, community leaders often find it difficult to find new sites for waste management facilities.

Balancing all of the management options in the solid waste hierarchy can be a major challenge. Many communities have invested resources in source reduction and recycling in an effort to reduce the amount of trash that must be landfilled or combusted. Yet reducing waste ultimately involves changing behaviors—purchasing environmentally friendly products when possible, and participating in recycling and composting programs.

Household Hazardous Waste

Leftover household products that contain corrosive, toxic, ignitable, or reactive ingredients are considered “household hazardous waste.” Examples of products that could become household hazardous waste include certain cleaning products, pesticides, motor oil, oil paints, adhesives, and batteries.

Unlike municipal solid waste, special care must be taken in disposing of household hazardous waste to minimize the impact on human health and the environment.

The best ways to reduce household hazardous waste are to use up all of the products or share them with someone else until they are used up, properly recycle them, or dispose of them according to your community’s solid waste regulations.

If you are unsure of what to do with these products, contact your local environmental or solid waste agency.

What are Some Emerging Trends?

Communities continue to seek ways to reduce waste. One recent trend is to charge residents for garbage collection services based on the amount of trash they throw away, known as “Pay-as-you-throw” (PAYT). By paying the garbage services in the same way as electricity, water and other utilities, residents have a direct incentive to reduce the amount of trash they generate and to recycle more.

Additional Information Resources

Visit the following Web sites for more information on municipal solid waste:

- U.S. Environmental Protection Agency (EPA): <www.epa.gov>
- U.S. EPA Office of Solid Waste site on municipal solid waste: <www.epa.gov/epaoswer/non-hw/muncpl/facts.htm>
- U.S. EPA Office of Solid Waste site on household hazardous waste: <www.epa.gov/epaoswer/non-hw/muncpl/hhwpubs.htm>

Teacher Fact Sheet

Natural Resources

What are Natural Resources?

Natural resources are useful materials from the Earth, such as coal, oil, natural gas, and trees. People depend on natural resources for basic survival and use them as raw materials to manufacture or create a range of modern conveniences. Water and food provide humans with sustenance and energy, for example, and fossil fuels generate heat as well as energy for transportation and industrial production. Many of the same natural resources are used by people are important to plants and wildlife for survival as well.

Virgin versus Recovered Resources

Resources used for the first time are considered virgin resources, and their extraction, processing, and use requires a great deal of energy and can create pollution. Resource recovery is a practice that conserves natural resources by extracting used materials (e.g., paper, glass, and metals) and energy from municipal solid waste and reprocessing them for reuse. For example, a company can create plastic from oil, a virgin natural resource, or it can use recovered plastic, it is actually saving materials that would otherwise become waste, helping to prevent the depletion of natural resources, conserving energy, and preventing pollution that would have been created in the extraction and processing of oil from the ground.

Key Points

- Natural Resources are vital to all forms of wildlife and the ecosystems in which they live.
- Human beings use natural resources for such modern conveniences as electricity, transportation, and industrial production, as well as being survival.
- Rapid population growth a higher standard of living and technology all contribute to increased use of natural resources.
- Extracting, processing, and using natural resources can cause environmental problems, such as the disruption or destruction of ecosystems; a decrease in biodiversity; and land, water, and air pollution.
- Using renewable natural resources impacts the environment less than using nonrenewable resources because their supply can be regenerated.
- Using recovered resources prevents natural resources from being wasted.
- Using recovered rather than virgin resources decreases greenhouse gas buildup, which can result in global climate change.
- Resource recovery and conservation, as well as buying recycled products, are emerging trends that reduce consumption of natural resources.

Biodiversity

Biodiversity refers to the variety of organisms that live on Earth. Supporting so many different organisms requires the conservation of the natural resources they need to survive. Using natural resources can not only deplete the Earth of the resources themselves, but by destroying critical habitats, it can also drive some species to extinction, ultimately reducing biodiversity.

In addition to the benefits already discussed, using recovered resources reduces threats to biodiversity. Natural resource extraction, along with other human activities, increases the rate at which species of plants and animals are now vanishing. Diminishing the Earth's biodiversity has a substantial human cost because wild species and natural ecosystems are important resources. For example, some economists estimate that the lost pharmaceutical value from plant species extinctions in the United States alone is almost \$12 billion. Reducing the land disturbance and pollution associated with virgin materials extraction by using recovered materials, therefore, helps stop the degradation of the Earth's ecosystems.

Renewable versus Nonrenewable Resources

Some natural resources are nonrenewable and some are renewable. Nonrenewable resources are those that become depleted more quickly than they naturally regenerate. One example of a nonrenewable resource is mineral ore. Once mined and used completely, it is gone forever, for all practical purposes, because it will take millions of years to regenerate. Renewable resources can be replenished at approximately the same rate at which they are used (for example, sun and wind, which can be used to provide energy).

What are the Benefits of Natural Resources?

Renewable resources offer a number of environmental and economic benefits over nonrenewable resources. One obvious benefit is the infinite supply of renewable resources—they cannot be depleted. Another benefit of using renewable resources is self-reliance. A country that can provide its own renewable resource, such as solar-powered electricity, need not rely on other countries for an energy source. Additionally, renewable resources offer communities relief during periods of recovery from natural disasters. When communities lose standard services that require the use of natural resources (e.g., electric power or natural gas), renewable resources, such as wind and solar energy systems are used to provide these services until the usual methods of achieving service can be restored. Following the 1992 Hurricane Andrew, for example, a south-Miami subdivision continued to have working streetlights because they were all photovoltaic (PV)-powered. The areas became neighborhood-gathering spots for a community left without electricity following the storm. In several cases, home equipped with PV systems were able to keep minimal services running and became emergency shelters for surrounding residents without power.

What are the Challenges of Using Natural Resources?

Extracting, processing, and using natural resources creates air, water, and land pollution, which can cause global environmental problems. For example, carbon dioxide, which is produced from deforestation, and from burning coal, oil, and natural gas, is a critical greenhouse gas. Many scientists believe that the buildup of greenhouse gases in the atmosphere can cause global climate change. Over time, this condition could pose serious dangers around the world, prompting such disasters as flooding, drought, and disease.

Renewable or Nonrenewable—or Both?

Some resources can be considered both renewable and nonrenewable. Trees are considered a renewable resource because their supply can be replenished (e.g., more trees can be planted). If, however, an entire forest of 400-year-old trees is cleared and a new-growth forest is planted, the supply of old-growth trees has not been replenished. It takes many generations for an old-growth forest to mature, and so, old-growth trees are considered nonrenewable. Trees are a complex resource because as a forest, their environmental and economic contributions often depend on their age. For example, clearing a forest of 200-year-old Redwoods, unlike clearing a forest of new growth pines, diminishes high levels of biodiversity only developed in old-growth forests.

Products Made from Natural Resources

People use an abundance of resources to survive in a continually developing world. Globally, however, some people live simpler lifestyles than others and therefore use fewer resources. The following table lists some natural resources and the products and services people produce from them.

Natural Resource	Product / Service
Trees	Paper, furniture, fuel
Cotton plant	Clothing
Oil/Petroleum	Plastic, fuel
Gas	Fuel
Coal	Fuel
Iron Ore	Steel Products
Bauxite ore	Aluminum products
Gold	Jewelry, dental material
Copper	Wire, coins, electrical
Manganese	Steel, cast iron
Cobalt	Steel, jet engine parts
Platinum	Stainless steel, gems
Diamonds	Jewelry, mechanical

In addition, extracting and using resources can disturb relationships within ecosystems. For example, the effects of clearing an old-growth forest for wood can destroy habitats used by many animals, forcing them to find homes elsewhere. If these animals leave an ecosystem, further disturbances can occur with plant and animal populations that depend on these species.

Additionally, with the absence of tall trees in the forest, lower vegetation would lose shade provided by the upper canopy, resulting in increased exposure to sunlight and decreased moisture. Changes in an ecosystem's climatic conditions will eventually change vegetation type, which will alter the kinds of animals that can exist in that community. Over time, if enough ecosystems are affected, an entire community type can change (e.g., over-harvested fields can turn into deserts).

Population growth, increasing affluence, technological change, and urbanization are all responsible for rapidly rising resource consumption all over the world. The relationship between the population growth and increased resource use varies among developed and undeveloped nations. For example, according to the Department of Energy, residents of the industrialized world comprise only 20 percent of the world's population, yet consume 86 percent of its iron and steel, and 76 percent of its timber. Despite the inconsistent relationship between resource use and developed and undeveloped nations, it is apparent that worldwide, more people use more resources. With population, technology, and lifestyle demands growing exponentially, people are using increasing amounts of many natural resources.

What are Ecosystems?

Ecosystems are self-regulating communities of plants and animals that interact with one another and with their nonliving environment. Examples of ecosystems include ponds, woodlots, and fields.

Organisms within an ecosystem are connected by energy. Individuals in a community feed on each other, thus transferring energy along a food chain or food web. In a food chain, energy is transferred from one organism to another in a linear form. For example, the sun provides fuel for a fig tree, which provides sustenance for wasps. The wasps are a food source for spiders, which are eaten by birds. More complex food webs can be thought of as a network, involving energy transfers among several organisms.

Emerging Trends

Increasing demands for natural resources have spurred new method for conserving existing resources. More and more companies are developing new and innovative technologies that use recycled materials as raw materials in the manufacture of products. Some steel producers, for example, use minimills and a manufacturing process that uses virtually 100 percent recovered scrap steel as the raw material.

How can you help?

An increasing number of individuals are also practicing conservation methods by using less—such as buying products with less packaging. Certain lifestyle changes, such as composting food scraps rather than buying fertilizer also preserve natural resources. Other suggestions for ways to practice conservation of natural resources are as follows:

- Reduce waste by reusing paper grocery and lunch bags or eliminate waste by using cloth bags.
- Donate old toys, clothes, furniture, cars and other items to organizations such as the Salvation Army rather than throwing them in the garbage.
- Close the recycling loop by purchasing recycled-content products and packaging.

Additional Information Resources

Visit the following Web sites for more information on natural resources and solid waste:

- U.S. Environmental Protection Agency (EPA): www.epa.gov
- U.S. EPA Office of Solid Waste composting site: www.epa.gov/epaoswer/non-hw/compost/index.htm
- World Resources Institute: www.wri.org
- Natural Resources Defense Council: www.nrdc.org
- United States Department of Energy's National Renewable Energy Laboratory: www.nrel.gov
- United States Department of Energy's Center of Excellence for Sustainable Development: www.sustainable.doe.gov

Teacher Fact Sheet

Source Reduction

What is Source Reduction?

Americans crave convenience—but at what cost? American households have more discretionary income than most households worldwide, spending more on products that create more waste. Over the last 40 years, the amount of waste each person creates has almost doubled from 2.7 to 4.46 pounds per day (that is almost 1,628 pounds per person per year)! Though reusing, recycling, and composting are all important methods of reducing the amount of waste produced, the most effective way to stop this trend is by preventing the production of materials that could become waste.

Source reduction, also known as waste prevention, is the practice of designing, manufacturing, purchasing, or using materials (such as products and packaging) in ways that reduce the amount or toxicity of waste. Source reduction can help reduce waste disposal and handling costs because it avoids the cost of recycling, municipal composting, land filling, and combustion. It also conserves natural resources and reduces pollution.

Preventing waste before it is generated is a common-sense way to save financial and natural resources, as well as reduce pollution. That is why the U.S. Environmental Protection Agency (EPA) encourages consumers, businesses, and governments to make source reduction their first priority in waste management practices. For waste that cannot be prevented, recycling is the next best choice. (See the Teacher Fact Sheet titled Recycling).

Waste is generated throughout the life cycle of a product—from extracting raw materials, to transporting materials, to processing and manufacturing goods, to using and disposing of products. Manufacturers that reuse materials in the production process or that use less material to manufacture products can decrease waste dramatically. Other ways that manufacturers practice source reduction include:

- Reduce the amount of packaging in the manufacture of items.
- Reduce the amount of toxic components in a product or use smaller quantities of items with high toxicity.
- Reuse parts in the manufacture of a product.
- Redesign products to make them more modular. This allows broken or unusable components to be replaced rather than discarding the entire item.

In addition to reducing the amount of materials in the solid waste stream, reducing waste toxicity by selecting nonhazardous or less hazardous materials for manufacturing is another important component of source reduction. Using less hazardous alternatives for certain items (e.g., cleaning products, pesticides), sharing products that contain hazardous chemicals instead of throwing out leftovers, reading label directions carefully, and using the smallest amount of a chemical necessary are some ways to reduce waste toxicity. (See the Teacher Fact Sheet on Solid Waste for information on safe household practices).

Key Points

- Source Reduction, also known as waste prevention, means reducing waste at the source. It can take many different forms, including reusing or donating items, buying in bulk, reducing packaging, redesigning products, and reducing toxicity.
- Source reduction also is important in manufacturing. Light weighting of packaging, reuse, and remanufacturing are all becoming more popular business trends. Purchasing products that incorporate these features supports source reduction.
- Source reduction can save natural resources, reduce pollution, reduce the toxicity of our waste, and save money for consumers and businesses alike.
- Incorporating source reduction into daily practices can require some challenging but worthwhile lifestyle changes.

Source reduction is a challenge requiring creativity and ingenuity, but devising ways to prevent waste can be very satisfying and even fun! There are many ways consumers can practice source reduction. Here are just a few examples:

- Choose products that do not use excessive packaging.
- Buy remanufactured or used items
- Buy items in bulk rather than multiple, smaller packages to decrease the amount of packing waste created.
- Maintain and repair durable items.
- Reuse bags, containers and other similar items.
- Borrow, rent, or share items that are used infrequently.
- Donate items instead of throwing them out.
- Leave grass clippings on the lawn (grasscycling) or use them for backyard composting.
- Rake fallen leaves for composting rather than bagging them and throwing them away.

As a classroom activity, ask students to provide examples of other creative way they can reduce waste.

Source Reduction Facts

- Since 1977, the weight of 2-liter plastic soft drink bottles has been reduced from 68 to 51 grams each. That means that 250 million pounds of plastic per year has been prevented from becoming part of the waste stream.
- When McDonald's reduced its napkin size by 1 inch, the company prevented 12 million pounds of paper from being thrown away each year. In 1999, McDonald's switched to lighter weight packaging for two of their sandwiches, conserving 3,200 tons of boxboard containers.
- State Farm Mutual Auto Insurance converted to electronic cameras for their claims processing, saving more than 50 tons of instant and 35 mm film.

(Source: EPA, 1996, 1999)

What are the Benefits of Source Reduction?

Reducing waste at the source is the ultimate environmental benefit. It means waste does not have to be collected, handled, or processed in anyway, which prevents pollution, saves energy, and saves money. In addition, by reducing consumption, fewer products are manufactured thus reducing the impacts that manufacturing can cause. For example, by manufacturing less, greenhouse gas emissions are reduced, which can make a difference in preventing global climate change.

Preventing waste also can mean economic savings for communities, businesses, schools, and individual consumers. Many communities have instituted "pay-as-you-throw" waste management systems in

which people pay for each can or bag of trash they produce that requires disposal. When these households reduce their waste at the source, they create less trash and, consequently, pay a lower trash bill.

Businesses also have an economic incentive to practice source reduction. Manufacturing costs can decrease for businesses that reduce packaging, which can mean a larger profit margin and savings that can be passed on to the consumer.

Schools also can share in the economic benefits of source reduction. Buying products in bulk frequently means a savings in cost. Often, what is good for the environment is good for the pocketbook as well.

What are the Challenges of Source Reduction?

Practicing source reduction is likely to require some change in daily routines. Changing some habits may be difficult, but the environmental returns on the effort can make it worthwhile. For example, while using disposable utensils might be convenient, using durable flatware saves resources and requires only slight more effort (for cleaning). On the other hand, if waste is not reduced, the economic and social costs of waste disposal and the environmental impacts throughout the life cycle of products will continue to grow, and it will become increasingly harder to make decisions about waste management.

Even if consumers decide to change their consumption habits, products with minimal packaging and nontoxic ingredients are not always available. Balancing the immediate convenience of easily available products with the long-term benefits of waste prevention will be an ongoing challenge.

What are some emerging Trends in Source Reduction?

Many companies are becoming more involved in source reduction by remanufacturing and reusing components of their products or the entire product. A toner cartridge for a laser printer is an example of a product that once was disposable but now is manufactured to be reused. Many products are manufactured to use “modular,” or replaceable, units.

One manufacturer of photocopy machine takes back and remakes equipment from more than 30,000 tons of used photocopiers. Parts from returned machines that meet internal criteria for manufacturing are reprocessed into new products. Parts that do not meet remanufacturing criteria and cannot be repaired are often ground, melted, or otherwise recycled into basic raw materials. The company estimates annual savings of several hundred million dollars in raw material, labor, and disposal as a result of design changes and product return programs.

Other companies are also taking advantage of more environmentally preferable ingredients as ways to reduce the weight of packaging. Some supermarkets across the country have instituted shelf-labeling programs to highlight products with less packaging or less toxic ingredients. Purchasing these items shows manufacturers that consumers encourage and support source reduction.

How can you HELP!

Students can play an important role in protecting the environment by practicing source reduction. Here are some simple practices to help prevent waste:

- Donate old clothes and other household items so they can be reused or sold for reuse.
- Consider taking a thermos of juice to school instead of individual disposable containers.
- Use concentrated products to get more product with less packaging.
- Use double-sided copying and printing features.
- Buy pens, pencils, toothbrushes, and other items with replaceable parts.
- Use a durable lunch container or bag instead of a disposable one.
- Consider using environmentally preferable cleaning products instead of those that contain potentially toxic ingredients.
- Consider buying items that have been remanufactured or can be reused, such as toner cartridges for the printer or tires for the car.
- Encourage companies to reduce unnecessary packaging and the use of hazardous components in products. Many companies offer toll-free numbers and Web sites for these comments.
- Compost cafeteria food waste and use the finished compost to mulch the plants and trees around the school grounds.

Additional Information Resources

Visit the following Web sites for more information on source reduction and solid waste:

- U.S. Environmental Protection Agency (EPA): <www.epa.gov>
- U.S. EPA, Office of Solid Waste site on source reduction: <www.epa.gov/epaoswer/non-hw/muncpl/reduce.htm>
- U.S. EPA, Office of Solid Waste site on global climate change and waste reduction: <www.epa.gov/globalwarming/actions/waste/index.htm>
- Reuse Development Organization: <www.redo.org>

Teacher Fact Sheet

Recycling

What is Recycling?

Recycling is a series of activities that includes the collection of items that would otherwise be considered waste, sorting and processing the recyclable products into raw materials, and remanufacturing the recycled raw materials into new products. Consumers provide the last link in recycling by purchasing products made from recycled content. Recycling also can include composting of food scraps, yard trimmings, and other organic materials.

How does Recycling Work?

Many people already recycle items like paper, glass, and aluminum. While these efforts are a vital part of the process, the true recycling path continues long after recyclables are collected from household bins or community drop-off centers. Collecting, processing, manufacturing, and purchasing recycled products create a closed circle or loop that ensures the overall success and value of recycling.

Collection

How and where recyclables can be collected vary by community. Some communities collect from residences, schools, and businesses; four primary methods are used:

- Curbside collection programs are the most common. Residents set recyclables, sometimes sorted by type, on their curbs to be picked by municipal or commercial haulers.
- Drop-off centers are locations where residents can take their recyclables. These centers are often sponsored by community organizations.
- Buy-back centers are local facilities where recycled-content manufacturers buy their products back from the consumers to remanufacture the used products into new products.
- Deposit/refund programs require consumers to pay a deposit on a purchased product. The deposit can be redeemed when the consumer brings the container back to the business or company for recycling.

Processing

After collection, some recyclables are “processed” prepared for delivery to manufacturing facilities. Processing usually includes making sure the materials are sorted properly and that contaminants (i.e., nonrecyclables) are removed. Recyclables are then usually sent to a materials recovery facility (MRF, pronounced “murph”) to be further sorted and then processed into marketable commodities for remanufacturing. Recyclables are bought and sold just like any other commodity, and prices for the change and fluctuate with the market. Each MRF has individual requirements about what materials it will accept, but most accept newspapers, aluminum cans, steel food cans, glass containers, and certain types of plastic bottles.

Manufacturing

Once cleaned and sorted, the recyclables move to the next part of the recycling loop—manufacturing. More and more of today’s products are being manufactured with recycled content.

- Recycled cardboard and newspaper are used to make new boxes, papers, and other products such as tissues, paper towels and toilet paper, diapers, egg cartons, and napkins.
- Recycled plastic called PET, which is found in soft drink, juice, and peanut butter containers, is used to make new products such as carpets, fiberfill (insulating material in jackets and sleeping bags), bottles and containers, auto parts, and paint brushes. Another kind of recycled plastic, HDPE, which is used in milk, water, detergent, and motor oil containers, can be remanufactured into trash cans, bathroom stalls, plastic

lumber, toys, trash bags, and hair combs. Numbers imprinted on the plastic product indicate has been manufactured and how it can be recycled. Not all communities recycle all types of plastic.

- Recycled glass is used again and again in new glass containers as well as in glasphalt (the roadway asphalt that shimmers in sunlight), road filler, and fiberglass.
- Recycled aluminum beverage cans, one of the most successful recyclables, are remade into new cans in as little as 90 days after they are collected. Recycled aluminum building materials.
- All steel products manufactured in the United States contain 25-30 percent or 100 percent recycled steel, depending on the manufacturing process used.

Recycling Facts

- By recycling 1 ton of paper, we save: 17 trees, 7,000 gallons of water, 380 gallons of oil, 3 cubic yards of landfill space, and enough energy to heat an average home for 6 months.
- Manufacturers can make one extra-large T-shirt out of only five recycled plastic soda bottles.
- Americans throw away enough aluminum every 3 months to rebuild our entire commercial air fleet.
- When one ton of steel is recycled, 2,500 pounds of iron ore, 1,400 pounds of coal, and 120 pounds of limestone are conserved.
- Recycling aluminum cans saves 95 percent of the energy required to make aluminum cans from scratch.
- The amount of aluminum recycled in 1995 could have built 14 aircraft carriers.

(Sources:: Weyerhaeuser Company, 1999; Steel Recycling Institute, 2000; American Forest and Paper Association, 2000; R.W. Beck, 1997; The Can Manufacturers Institute, 1997; Anchorage Recycling Center, 2000; Recyclers' Handbook by Earthworks Group, 1997; EPA, 1997)

Purchasing Recycled Products

The market for recycled materials is the final part of recycling loop. Recycled products must be bought and used in order for the entire recycling process to succeed.

Recycling and composting activities divert about 62 million tons of material from landfills and incinerators. In 1997, this country recycled 28 percent of its waste, a rate that has almost doubled over the past 15 years. Of that 28 percent, here is the breakdown of what the United States recycled that year:

As individuals, businesses, and governments in the United States have increasingly assumed responsibility for wastes, recycling, reuse, and composting have all undergone a phenomenal surge in popularity and success. Analysts project that American will be recycling and composting at least 83 million tons—35 percent of all municipal waste—by 2005.

What are the Benefits of Recycling?

When each part of the recycling loop is completed, the process helps both the environment and the economy. Recycling prevents materials from being thrown away, reducing the need for landfilling and incineration. In addition, the use of recycled materials to manufacture new products prevents pollution caused by the manufacturing of products from virgin materials. Also, using recycled materials for manufacturing decreases emissions of greenhouse gases that contribute to global climate change. Since the use of recycled materials reduces the need for raw material extraction and processing, energy is saved and the Earth's dwindling resources are conserved.

Recent studies indicate that recycling and remanufacturing account for about one million manufacturing jobs throughout the country and generate more than 100 billion in revenue. Many of the employment opportunities created by recycling are in areas where jobs are most needed.

Recycling in Action

For recycling to work, everyone has to participate in each phase of the loop. From government and industry, to organizations, small businesses, and to people at home, all Americans can easily make recycling a part of their daily routine. Below are some ways for individuals to get involved in recycling:

- Learn about and participate in a community-recycling program. Know the collection schedule or drop-off location as well as which items are acceptable. Get involved by volunteering with a homeowner's association or community organization to educate neighbors about the recycling program.
- Empty all fluids and remove all lids from bottles and cans when recycling and do not contaminate recycling containers with trash.
- Participate and encourage colleagues to recycle in the containers provided in your school. Initiate a recycling program in your school if one does not exist.
- Make the effort to find recycling opportunities for items, such as plastic packaging that are not included in your local recycling program.
- Use recyclable products and encourage others to do the same.

What are the Challenges of Recycling?

Despite its success, the potential of recycling in this country is not yet fully realized. Some plastics, for example, such as bottles and containers, are recyclable in almost any community, but others, such as plastic "peanuts" used in packaging, usually can not be included in curbside or drop-off recycling programs. These items still end up in the trash because it is not profitable to collect the tons needed for remanufacture into new products. In addition, the costs of collecting, transporting, and processing recyclables can sometimes be higher than the cost of disposing of these materials as waste. The average cost to process recyclables is \$50, while the average value of those recyclables on the market is only \$30. Processors often compensate for this discrepancy by charging a set fee for each ton of material they receive or by establishing ongoing contracts with communities or haulers. Efforts to better manage waste and recycling programs are under development. Many communities across the country implement financial incentives to encourage people to recycle. Residents are charged a fee based on the amount of solid waste they throw away. The more a household recycles, the less garbage it throws out, and the lower collection fee it pays.

Finally, recycling facilities are not always a welcome addition to a community. As with other waste management operations, recycling facilities are often accompanied by increased traffic, noise, and even pollution. Community leaders proposing the location for a recycling facility can encourage the NIMBY (Not in My Backyard) sentiment.

Is Your School Waste Wise?

WasteWise is a voluntary EPA partnership program that helps businesses, governments, and institutions reduce waste and save money. Since the program began in 19974, WasteWise partners have reduced their municipal solid waste by more than 26 million tons! In 1998 alone, partners saved an estimated \$264 million. Partners include many large corporations, small and medium-sized businesses, hospitals, tribes, and state, local, and federal governments, as well as 87 schools, school districts, colleges, and universities in more than 30 states.

The following are examples of the accomplishments of a few WasteWise partners in the education field, Alden Central School of New York, which educates children from K-12, implemented a comprehensive waste reduction program in all campus buildings. Students and staff eliminated 450 pounds of polystyrene cafeteria trays and dishes by switching to reusable products. They also composted 900 pounds of cafeteria food scraps and 150 pounds of yard trimmings for use as mulch on building grounds. Sligo Adventist School of Maryland also implemented several innovative waste prevention activities including the reduction of more than 1 ton of drink boxes by switching to bulk juice dispensers. Eastern Illinois University reduced the amount of computer paper used on campus by 10 percent and reused 13 tons of office supplies through an internal exchange among employees.

To find out how your school can join the WasteWise program, please call 800-EPA-WISE (372-9473), email at ww@cais.net, or visit the Web site at www.epa.gov/wastewise.

Additional Information Resources

Visit the following Web sites for more information on recycling and solid waste:

- U.S. Environmental Protection Agency (EPA): www.epa.gov
- U.S. EPA, Office of Solid Waste site on recycling: www.epa.gov/eapower/non-hw/muncpl/reduce.htm
- U.S. EPA, Office of Solid Waste WasteWise Program site: www.epa.gov.wastewise/index.htm
- U.S. EPA, Office of Solid Waste on global climate change and recycling: www.epa.gov/mswclimate/index.htm
- U.S. EPA, Office of Solid Waste, Kid's Page: www.epa.gov/eapower/osw/kids.htm
- U.S. EPA, Region 9 Office's Recycling site for Kids: www.epa.gov/recyclecity
- National Recycling Coalition: www.nrc-recycle.org
- Institute for Scrap Recycling Industries: www.isri.org
- American Plastics Council: www.plastics.org
- Steel Recycling Institute: www.recycle-steel.org/
- Aluminum Association: www.aluminum.org
- Glass Packaging Institute: www.gpi.org
- American Forest and Paper Association: www.afandpa.org
- Institute for Local Self-Reliance: www.ilsr.org
- Rechargeable Battery Recycling: www.rbrc.org
- Polystyrene Packaging Council: www.polystyrene.org

Teacher Fact Sheet

Landfills

What is a Landfill?

A landfill is a large area of land or an excavated site that is specifically designed and built to receive wastes. Today, about 55 percent of our country's trash is disposed of in landfills (EPA, 1998). Items such as appliance, newspapers, books, magazines, plastic containers, packaging, food scraps, yard trimmings, and other wastes from residential, commercial, and some industrial sources can be disposed of in municipal solid waste landfills. Municipal solid waste landfills can also accept some types of hazardous waste, such as cleaning products, paint and chemicals, as well as some industrial wastes from certain businesses. Many states and communities, however, promote the safe collection of these hazardous wastes through local programs.

Key Points

- Landfills are the most common form of waste disposal and are important component of an integrated waste management system.
- Federal landfill regulations have eliminated the open dumps of the past. Today's landfills must meet stringent design, operation, and closure requirements.
- Methane gas, a byproduct of decomposing waste, can be collected and used as fuel to generate electricity.
- After a landfill is capped, the land may be used for recreation sites such as parks, golf courses, and ski slopes.
- Landfills that handle hazardous wastes are specially designed with two sets of liners and two leachate detection systems.

Cross Section of a landfill



In the past, garbage was collected in open dumps. These uncovered and unlined sites allowed leachate, a liquid formed by decomposing waste, to soak into the soil and ground water. Open dumps also attracted rodents and insects, emitted odors, and created fire hazards. Most of these small and unsanitary dumps have been replaced by large, modern facilities that are designed, operated, and monitored according to strict federal and state regulations. Today's landfills eliminate the harmful and undesirable characteristics of dumps to help protect public health and the environment.

In addition to being safer for the environment and neighboring communities, these larger landfills hold more trash than the dumps of the past. In 1998, about 2,300 municipal solid waste landfills were operating in the United States (EPA, 1998). While this number is significantly smaller than the number landfills 25 years ago, new landfills—can accommodate significantly more garbage. This greater capacity is necessary to keep up with the steady growth of municipal solid waste.

How does a Landfill Work?

A typical modern landfill is lined with a layer of clay and protective plastic to prevent the waste and leachate from leaking into the ground or groundwater. The lined unit is

then divided into disposal cells. Only one cell is open at a time to receive waste. After a day's activity, the garbage is compacted and covered with a layer of soil to minimize odor, pests, and wind disturbances.

A network of drains at the bottom of the landfill collects the leachate that flows through the decomposing waste. The leachate is sent to a leachate recovery facility to be treated. Methane gas, carbon dioxide, and other gases produced by the decomposing waste are monitored and collected to reduce their effects on air quality.

Landfills are regulated by federal and state laws. The federal laws dictate where landfills can be located, such as away from unstable land prone to earthquakes or flooding, and require them to be lined and have a leachate collection system. In addition, landfill owners must monitor and collect explosive gases; regularly test nearby ground water; and compact and cover waste with a layer of soil on a daily basis.

Many states require landfill operators to obtain a license and present a plan for how the site will be safely closed, even though the closing date might be 50 years in the future. Furthermore, federal law requires landfill owners to set aside the money to close the landfill properly and support ongoing monitoring activities. Once a landfill is capped (closed), the operator must monitor the site for gas and leachate for a minimum of 30 years after the closing date. In addition to federal regulations, each state has its own landfill requirements, which are often more stringent than the federal laws.

Are there Landfills for Hazardous Waste?

Each year, about 29 million ton of hazardous waste are disposed of in landfills or other land disposal sites. Hazardous waste is toxic, ignitable, corrosive, or reactive, or generated from certain industries or manufacturing processes. When it come to disposing of hazardous waste in landfills, EJPA takes additional steps to ensure environmental safety and human health.

While landfills that accept solid waste have a clay and plastic liner and a leachate system to prevent leakage, landfill owners that accept hazardous waste must take extra precautions. For example, a hazardous waste landfill must two sets of liners, one consisting of special plastic, and the other composed of both plastic and a thick layer of soil material. In addition, a landfill accepting hazardous waste must have two leachate detection systems instead of just one.

Before hazardous waste even reaches a landfill, however, it must be treated differently than solid waste. If hazardous waste is bound for disposal in a landfill, it is regulated under EPA's Land Disposal Restrictions Program. Through this program, hazardous waste must undergo treatment that will destroy or immobilize its hazardous components before it is sent to a landfill. For example, when a business generates hazardous waste, it must either treat that waste itself, or send it to a special facility for treatment, before sending the waste to a landfill.

What are the Benefits of Landfills?

In addition to providing a cost-effective, safe method to dispose of ever-increasing amounts of trash, landfills often provide other services to the community. For example, some landfills collect methane, a gas created by decomposing garbage that can contribute to global climate change, and convert it into an energy source. In addition, after a landfill is capped and a certain amount of time has passed, the land might be reused for parks, ski slopes, golf courses, and other recreation areas.

What are the Challenges of Landfills?

Though regulations have made landfills safer to the public and the environment, public opposition, high land prices, and environmental concerns can make it difficult to find suitable places for new landfills.

Landfills can pose other problems if not properly designed or managed. If a liner leaks, for example, the underlying soil and ground water can become contaminated. Additionally, since landfills are often located in remote areas, waste must be hauled long distances, which might result in environmental impacts from increased truck traffic (e.g., air pollution) and noise from truck traffic and the use of equipment onsite. Additionally, within a given municipality, landfills often compete for local garbage. Competition can lead to reduced support for recycling and other waste reductions programs. Issues also might arise if a landfill is located close to a community. Many people do not want landfills near their homes. The NIMBY (not in my backyard) attitude can make finding a landfill site very challenging.

What are some Emerging Trends?

Increased waste generation requires landfills operators and managers to constantly evaluate and improve current disposal methods. One strategy to speed the rate of decomposition of landfill waste is to recirculate the collected leachate by pouring it over the cells and allowing it to filter through the rotting garbage.

Landfill Facts:

- The first garbage dump was created in 500 B.C. by the ancient Greeks in Athens. Residents were required to take their trash 1 mile away from the city walls to dump.
- Paper takes up as much as 50 percent of all landfill space. Recycling 1 ton of newspapers would save 3 cubic feet of that space.
- In a study of waste buried for more than 15 years, Professor William Rathje of the University of Arizona found legible newspapers and chicken bones with meat still on them, proving that waste does not decompose completely in a landfill.

(Sources: The League of Women Voters' Garbage Primer, 1993; Rubbish! The Archaeology of Garbage by William Rathje, 1990; Anchorage Recycling Center, 2000)

Another trend that is becoming common for landfill operators is collecting methane gas from the landfill and using it as energy source to the power the landfill or selling it to a local utility provider, company, or even greenhouses. This process allows landfills to reduce their dependence on precious fossil fuels and save money.

A new trend that is gaining attention is landfill reclamation, in which old cells are excavated to recover recyclable items. This process, in which recovered recyclables, soil, and waste can be sold, reused, or burned as fuel, is a new approach used to expand landfill capacity and avoid the cost of acquiring additional land.

Putting Landfill Gas to Use

1 million tons of waste within a landfill creates 300 cubic feet per minute of landfill gas, or one megawatt of electricity. That is enough to power 700 homes for a year. Removing that much methane gas from the atmosphere is equal to taking 6,100 cars off the road for a year.

Additional Information Resources:

Visit the following Web sites for more information on municipal solid waste landfills:

- U.S. Environmental Protection Agency (EPA): <www.epa.gov>
- U.S. EPA, Office of Solid Waste site on landfills: <www.epa.gov/epaoswer/non-hw/muncpl/disposal.htm>
- U.S. EPA Landfill Methane Outreach Program: <www.epa.gov/lmop>

For more information on the disposal of hazardous waste in landfills, visit:

- U.S. EPA, Office of Solid Waste site on Land Disposal Restrictions: <www.epa.gov/epaoswer/hazwaste/ldr>
- U.S. EPA, Office of Solid Waste site on RCRA Hotline Training Modules (hazardous waste land disposal units): <www.epa.gov/epaoswer/hotline/modules.htm>

The following trade associations can provide information about landfills as well:

National Solid Waste Management
Association
4301 Connecticut Avenue, NW, Suite 300
Washington, DC 20008
Phone: 202/244-4700
Web site: www.envasns.org/nswma

Solid Waste Association of North
America
P.O. Box 7219
Silver Spring, MD 20907-7219
Phone: 301/585-2898
Web site: www.swana.org

Teacher Fact Sheet

Products

How Are Products Made?

Everyone uses a variety of products each day from toothbrushes to notebooks to lunch boxes to video games. Each of these products has an effect on the environment in one way or another. Sometimes merely using (or misusing) a product can affect the health of people and the environment. Some products can affect the environment through the way they are made or disposed of. For example, products made from the virgin natural resources have different effects on the environment than those made from recovered resources. By understanding a product's life cycle---the development, use, and disposal of a product---people can make better decisions about what products to buy and how to use them wisely.

A product's life cycle generally includes design; exploration, extraction, and processing of resources (raw materials); manufacturing; distribution and use; and retirement. If a product is made from 100 percent recovered materials, exploration and extraction of virgin materials is not necessary. If a product is recycled, composted, or reused, people do not have to throw it away. By altering the product life cycle in these ways, people can save energy and resources, and therefore, prevent waste and pollution.

Key Points

- Product life cycle includes design, extraction of natural resources, manufacture, use, and disposal or recycling. If a product is made with recovered materials, raw materials do not have to be extracted from the Earth. If a product is recycled or reused, its life cycle begins anew and has less effect on the environment.
- The extraction of raw materials and the manufacture and disposal of a product can create pollution and waste and can require a great deal of energy resources.
- Durable products can be used many times, while disposable products are usually used only once.
- Product manufacturers are beginning to make more products that have environmentally preferable attributes.

The Product Life Cycle

The following sections describe each stage in the product life cycle, as well as the challenges, benefits, and emerging trends associated with each step.

Design

Product design can involve research, testing, and development. This includes development of synthetic materials, such as plastics, which derive from natural resources.

Some products are designed to be used only once (disposable), while others are designed to be used many times (durable). Engineering and material choices can determine whether a product is durable, disposable, or recyclable.

Over the last few decades, as people's lives have become more complicated and technology has advanced, many consumers have come to desire the convenience of disposable items over the durability of reusable ones. Also, it is sometimes easier to replace items rather than fix them. Thus, more and more items end up as trash in landfills or incinerators.

Products are often conceived and designed with a focus simply on how they will be used and with less concern about the other stages in their life cycle. In the past decade, however, consumers have begun to demand more environmentally preferable products---products that have fewer negative effects on human health and the environment when compared to traditional products. Manufacturers have responded by offering products that are made from recycled-content materials, low in toxicity, and highly energy-efficient. Other products have been designed to conserve water, minimize air pollution or, through a combination of factors, have fewer negative impacts on the environment.

Exploration, Extraction, and Processing

Manufacturers must obtain the materials needed to make their products. If a manufacturer uses recovered materials, the company can obtain them from recycling processors or other similar sources. Virgin resources, however, must be mined (for metals and minerals) or harvested (for wood and other biobased materials) from the Earth. Once they are extracted, they must be processed for use in manufacturing.

The extraction of raw materials generates waste and pollution and requires a great deal of energy. In many cases, the natural resources used in manufacturing are nonrenewable. This means that, eventually, the natural resource will be depleted. As more and more communities offer recycling programs and people use them, manufacturers may be able to use increased recovered materials instead of virgin materials to make products.

Manufacturing

Whether a product is made from virgin or recovered materials, often the factories that manufacture the product are specially designed to use a consistent form of material. If a product is made in a plant designed to process virgin materials, changing to recycled feedstock might not be easy. Changing the kinds of materials used in manufacturing, such as using recycled paper instead of virgin paper, can require changes in technology and equipment and can slow down the pace of production. In the past decade, however, many manufacturing plants have begun retooling and learning to use recovered materials rather than virgin materials, and thus, the variety of recycled-content products has been growing. (See teacher fact sheet titled Recycling).

Manufacturing products generates pollution and usually requires a great deal of energy resources.

Using recovered materials can often save energy and reduce pollution. The manufacturing process also generates waste, but at some manufacturing plants, this waste can be reused.

Distribution and Use

People rely on various products to live in a modern society. Most people purchase and use some type of manufactured product everyday because it is easier and more convenient than making the same items from scratch (for example, going to a store and buying a box or bag of rice is much simpler, and more practical, than trying to grow rice in a paddy in the backyard).

After products are manufactured, many must be packaged for transportation and distribution. Often, products are transported long distances across the nation or even internationally before people can purchase and use those items. Products often require packaging to protect them from spoilage, damage, contamination, and tampering during

Product Facts:

- Most glass bottles and jars contain at least 30% recycled glass.
- Making 2,000 pounds of paper from trees requires 3,700 pounds of wood, 200 pounds of lime, 360 pounds of salt cake, 76 pounds of soda ash, 24,000 gallons of water, and 28 million BTUs of energy.
- It requires 95 percent less energy to make an aluminum can from recycled material than from the natural resource raw material, bauxite ore.
- For every 100 pounds of products made, over 3,000 pounds of waste is generated.

(Sources: Glass Packing Institute; Can Manufacturers Institute; Weyerhaeuser Company.)

Think Globally, Buy Locally

One way consumers can help eliminate the need for excessive packaging is to buy products locally. This concept, known as bioregionalism, works on the idea that if consumers buy products made within their own communities, packaging that would otherwise be needed to protect the products during transportation and storage could be eliminated.

transportation, storage, and sale. Sometimes packaging is necessary to inform consumers about product benefits, proper use, and other information. While some products might appear to have excessive packaging, in many cases the packaging serves several purposes, without which the products might not be available as widely or as frequently.

Packaging—when it is discarded—can create a great deal of waste. In communities where common packaging materials are not recyclable, these items must be thrown away, wasting precious resources and potential recovered materials.

Product Retirement

After use, many items or packaging are disposed of in landfills or incinerators, they can no longer provide any benefit. Emissions to air and water from these disposal methods can affect human health and the environment.

If products are recycled, composted, or reused, they continue to serve a purpose, either as a raw material or for the same use they were originally intended. Extending a product's life is a way to save natural resources, prevent waste, reduce pollution, and conserve energy.

The more people recycle and buy recycled products, the more incentive manufacturers will have to make products with recovered content.

Additional Information Resources:

Visit the following websites for more information on designing and purchasing products with the environment in mind:

- U.S. Environmental Protection Agency (EPA): <www.epa.gov>
- U.S. Office of Solid Waste extended product responsibility site:
<www.epa.gov/epaoswer/non-hw-reduce/epr/index.htm>
- U.S. EPA Office of Pollution and Toxics, Design for the Environment Program:
<www.epa.gov/dfe>
- U.S. EPA Office of Pollution Prevention and Toxics, Environmentally Preferable Purchasing:
<www.epa.gov/opptintr/epp>

Teacher Fact Sheet

Composting

What is Composting?

Composting is the controlled thermophilic decomposition of organic materials such as leaves, grass, food scraps by various organisms.

Composting can be divided into three types: backyard, or home, composting; vermicomposting; and heat based composting.

Home composting is the natural degradation of yard trimmings, food scraps, wood ashes, shredded paper, coffee grounds, and other household organic waste by naturally occurring microscopic organisms. Vermicomposting is the natural degradation of similar household organic waste using naturally occurring microscopic organisms and the digestive process of earthworms. Heat based composting is performed by municipal or commercial facilities that increase the rate of degradation using high temperatures.

Composting in Action

An easy way to understand all the factors that go into composting is with a hands-on demonstration. A school can provide the perfect medium for these demonstrations. Classes could start a composting bin using food scraps from the cafeteria and yard trimmings from ground maintenance. Depending on the scope of the project, the compost could then be sold to the community in addition to being used on the school campus. Tour a local composting facility, if composting cannot be done at school. For more information on how to start a school composting project, go to the Cornell University composting Web site at: www.cfe.cornell.edu/compost/schools.htm Or use these suggested activities to get you started:

- Start a compost pile or bin in the school or as a class experiment.
- Try using compost in place of chemical fertilizers, pesticides, and fungicides. Use compost made by the school or buy it from municipalities or private companies.

Key Points

- Composting is the controlled decomposition of organic materials.
- Composting helps divert a large portion of America's organic trash from landfills and combustion facilities.
- There are three methods of composting: home or backyard composting, vermicomposting, and heat-based composting.
- Invertebrates and microorganisms in compost are key to the breakdown of the organic materials into a rich soil-like product.
- Quality compost is the result of the proper mixture of carbon and nitrogen sources and adequate amounts of moisture, oxygen, and time. Certain food items should be avoided when home composting.
- Compost is a valuable product that can be used as a soil amendment, mulch, or even to decontaminate natural habitats, storm water, and brownfields.
- More than 75 percent of the waste produced in the United States (including paper) is compostable material.

Varying amounts of heat, water, air, and food produce different qualities of compost as a final product. Heat based compost differs from compost produced at ambient temperatures (e.g., a forest floor or home composting) because high temperatures destroy both weed seeds and pathogens. Compost produced by all three systems are crumbly, earthy-smelling, soil-like materials with a variety of beneficial organisms.

How Does Composting Work?

Compost contains both carbon and nitrogen sources, which can be simplified as browns (e.g., leaves, straw, woody materials) and greens (e.g., grass and food scraps), respectively. Adequate sources of carbon and nitrogen are important for microorganism growth and energy. The ideal ratio is 30 parts brown to 1 part green. Odor and other

problems can occur if the ratio or any of the factors discussed below are not right.

The browns and greens can be mixed together to form compost in a backyard bin or in a municipal compost facility. Whether the composting is done on a small scale or large, the composting process is the same. To encourage decomposition throughout the pile, the compost should be kept moist and turned periodically.

The decomposition of organic materials in composting involves both physical and chemical processes. During decomposition, organic materials are broken down through the activities and appetites of bacteria, fungi, and various invertebrates that will naturally appear in compost, such as mites, millipedes, beetles, sowbugs, earwigs, earthworms, slugs, and snails. These insects and microorganisms found in decomposing matter need adequate moisture and oxygen to degrade the organic materials in the most efficient manner.

What are the Benefits of Composting?

As a method of handling the large amount of organic waste created in the United States each day, composting makes good environmental sense. Instead of throwing organic materials away, they can be turned into a useful resource.

In addition, many organic wastes are not ideally suited for disposal in combustion facilities or landfills. Food scraps and yard trimmings tend to make inferior fuel for combustors because of their high moisture content. Decomposition of organic wastes in landfills can create methane, a green house gas that is environmentally harmful because it destroys atmospheric ozone.

Because yard trimmings and food scraps make up about 23 percent of the waste U.S. households generate (EPA, 1998), backyard or home composting can greatly reduce the amount of waste that ends up in landfills or combustors. In addition, compost is a valuable product that can be used as a soil additive for backyard gardens and farmlands or in a highway beautification and other landscape projects.

The benefits don't end there—composting also makes good economic sense. Composting can reduce a community's solid waste transportation, disposal, and processing costs. In many communities, residents pay for each bag or can of trash they put out for pickup. If a household is composting, it will most likely put less in trashcan and will pay a smaller trash bill.

Compost can improve the soil structure of home gardens and farmlands alike by enhancing the soil's capacity to hold moisture and nutrients. This can reduce the need to purchase chemical fertilizers. Adding compost to soil attracts earthworms, which aerate the soil and add additional nutrients. When used as mulch, compost can help prevent erosion by improving soil structure, promoting vegetative growth, and slowing water runoff. Applying compost to soils reduces the likelihood of plant diseases. This is due to the beneficial microorganisms present in compost, which can kill pathogens in the soil. Compost can also be used to decontaminate natural habitats, storm water, and brownfields.

What can go into a Composting Bin?

This list is not meant to be all-inclusive. Some food products should not be included because they can attract pests or compromise the quality of the compost.

Materials to Include

Fruit and vegetable scraps
Tea Bags
Wool and cotton rags
Coffee grounds with filters
Grass / Yard Clippings
Leaves
Egg Shells
Sawdust
Fireplace ash
Non-recyclable paper
Vacuum cleaner lint
Fish scraps

Materials to Exclude

Meats
Dairy foods
Bones
Fats
Pet excrement
Diseased Plants
Grease
Oils (including peanut butter and mayonnaise).

In backyards and on the community level, interest in composting has increased rapidly over the past several years. Yard trimmings programs constitute the large majority of composting operations in the United States. In these programs, community members place their yard trimmings in a separate bag or container at the curb, which is collected and taken to a municipal composting facility. These facilities create large amounts of compost, which, in many cases, is sold back to community members. People can also purchase compost created by private composting companies.

What are the Challenges Associated with Composting?

Creating quality compost requires the right mix of materials and attention to moisture, particle, size, and temperature. Too little moisture will slow the decomposition, but too much can create odor problems. To avoid attracting pests and rodents, composters should monitor the food scraps put in the compost pile. Meat scraps, fats, and oils are difficult items to compost, attract pests, and should be kept away from the compost pile.

While composting increases the rate of natural organic decomposition, it still takes months for compost to mature. If compost is used while it is still “cooking,” the high temperatures could kill the plant life on which it is spread. In addition, using compost before it is ready can encourage weed growth because the high temperatures of the pile have not had a chance to kill any potential weed seeds.

What are Some Emerging Trends in Composting?

A large amount of organic waste is created by institutions, restaurants, and grocery stores—perfect for compost. Across the country, many of these businesses are participating in pilot projects to compost their food scraps and soiled paper products. These businesses cannot only provide a valuable component of compost—organic material—but also can reduce their waste disposal cost significantly.

Compost is also being used as an innovative technology to clean up land contaminated by hazardous wastes, remove contaminants from storm water, facilitate reforestation, and restore wetlands and other natural habitats. Compost has been used to restore soil that is contaminated with explosives, munitions wastes, petroleum, fuel wastes, and lead and other metals. In addition, various biodegradable tableware and dishes are being tested for compostability.

Worms—A Composter’s Best Friend

Vermicomposting is a method of composting using a special kind of earthworm known as a red wiggler (*Eisenia Fetida*), which eats its weight in organic matter each day. Vermicomposting is typically done in a covered container with a bedding of dirt, newspaper, or leaves. Food scraps (without added fats) can then be added as food for the worms. Over time, the food will be replaced with worm droppings, a rich brown matter that is an excellent natural food plant. Vermicomposting requires less space than normal composting methods, and is therefore ideal for classrooms, apartments, and those in high-density urban areas.

Additional Information Resources:

Visit the following Web sites for more information on composting and solid waste:

- U.S. Environmental Protection Agency (EPA): www.epa.gov
- U.S. EPA, Office of Solid Waste site on composting: www.epa.gov/compost
- Cornell University composting site: www.cals.cornell.edu/dept/compost/composting_homepage.html
- U.S. Composting Council Web site: www.compostingcouncil.org

Teacher Fact Sheet

Combustion

What is Combustion?

Recycling, composting, and source reduction are vital activities for effective solid waste management, but 100 percent of people's trash cannot be handled by these methods. The remaining waste must be deposited in landfills or combusted (burned). Because of limited space, landfills are not always a viable option in many cities, making combustors (commonly referred to as incinerators) an important part of a community's integrated waste management system. Burning garbage can decrease the volume of waste requiring disposal by 70 to 90 percent.

Before the late 1970's, many people burned garbage in their backyards and in simple private and municipal combustors. These methods did not burn garbage completely, however, and allowed pollutants to escape into the atmosphere. With the passing of the Clean Air Act, combustor owners were directed to develop more effective methods of pollution control. Today's municipal waste combustors release significantly less pollutants into the air than the "backyard burners" and simple combustors. More than 100 municipal waste combustor plants currently exist nationwide, and nearly 20 percent of the municipal solid waste generated in the United States is combusted.

Key Points

- Municipal waste combustors burn waste at high temperatures to reduce its volume.
- The heat produced by burning waste in municipal waste combustors can be recovered as useful energy.
- Municipal waste combustors reduce the volume of garbage by 70 to 90 percent.
- Ash is a byproduct of combustion that must be disposed of in landfills or reused.
- Air pollution control equipment helps reduce air emissions.
- Specially designed incinerators can be used as a means of handling hazardous waste. The burning process reduces the toxicity of organic compounds in the waste.

How do Municipal Waste Combustors Work?

Municipal waste combustors dispose of trash by burning it at high temperatures. Not all municipal waste combustors are designed alike, but they function in a similar manner. Typically, a facility collects waste in a garbage receiving area or pit, where the garbage is mixed by a crane. The crane operator looks for large items that are not suitable for combustion (e.g., batteries and refrigerators) and remove them from the pit. The crane operator also uses the crane to lift piles of garbage into a large chute. From the chute, garbage falls into a combustion chamber or furnace and then moves along a series of sloping grates that work like conveyor belts. The garbage is burned as it moves forward.

After garbage is burned, some matter remains in the form of ash. There are two types of ash: bottom ash and fly ash. Bottom ash is the heavier, nonburnable material, such as glass and metal, that falls through the grate after burning. Large pieces of metal accumulate in this ash and are extracted from the ash with magnets. Bottom ash accounts for the majority of ash produced by incinerators, about 75 to 90 percent. Fly ash includes lighter particles that rise with hot gases as the garbage is burned and are captured by air pollution control equipment in the stacks. All ash generated by combustion facilities must be tested to determine if it is hazardous. If deemed hazardous, the ash is subject to special hazardous waste disposal regulations. If the ash proves nonhazardous, it may be deposited in landfills specially designed to store it. Currently, studies are under way to investigate ways to reuse ash; for example, to replace soil as a landfill cover (generally applied at the end of each day to minimize odor, pests, and wind disturbances). Ash might also be used in road and building construction and as part of artificial offshore reefs. Whether the leftover ash is recycled or landfilled, it takes up much less space than the same materials in their original form.

Facts about Municipal Waste Combustors

- Fire in the boiler of a combustor is often as hot as flowing lava (between 1,800 and 2,200 degrees Fahrenheit).
- In 1874, a new technology called “the destructor” provided the first combustor of municipal garbage in England.
- The first garbage incinerator in the United States was built on Governor’s Island, New York, in 1885.

(Sources: Integrated Waste Services Association, 2000; Rubbish! The Archaeology of Garbage by William Rathje, 1990)

What are the Benefits of Municipal Waste Combustors?

Most municipal waste incinerators in the United States generate energy in the form of electricity because certain materials, such as paper, plastics, wood, and packaging, make excellent fuels. Producing this energy has about the same environmental impact as energy produced from natural gas and less of an environmental impact than energy produced from oil or coal. In other words, generating energy from municipal waste combustors contributes no more pollution—and sometimes less—than processes generating electricity using natural gas, oil, or coal. Waste-to-energy plants also reduce the need to generate electricity from nonrenewable natural resources such as oil and coal.

What are the Challenges of Municipal Waste Combustors?

Although technologies to control pollution have improved significantly, burning certain materials still produces chemicals that contribute to air pollution. To minimize emissions of air pollutants into the atmosphere, municipal waste incinerators use special equipment (e.g., scrubbers and dust collectors) to remove pollutants. To protect air quality and monitor the hazardous constituents in ash, EPA established regulations that apply to all large municipal solid waste units (those with the capacity to burn more than 250 tons of garbage per day). The regulations significantly reduce toxic air emissions such as dioxin, acid gas, lead, cadmium, and mercury.

Many people do not want incineration sites near their homes. The NIMBY (Not in My Back Yard) attitude makes finding appropriate sites for municipal waste combustors a challenge for many municipalities. There are, however, opportunities for the public to participate in deciding where a combustor will be located. Officials must hold a public meeting to inform the community about the size of the combustor, as well as the amount of waste generation and ash to be discarded.

Hazardous Waste Combustion

In addition to combustion facilities that accept municipal (nonhazardous) waste, specially designed incinerators, boilers, and industrial furnaces, can burn hazardous waste. Hazardous waste, which is toxic, ignitable, corrosive, or reactive, can be produced by businesses or manufacturing operations. Combustion has some key advantages as a means of managing hazardous waste. First, burning hazardous waste reduces the volume of waste by converting solids and liquids to ash. Second, the burning process destroys toxic organic compounds in waste. Third, disposal of the ash in a landfill is safer and more efficient than disposal of untreated hazardous waste. The ash generated from hazardous waste combustion must be tested and, if found to be hazardous, must be treated and, if found to be hazardous, must be treated for remaining toxicity before it is disposed of in a landfill.

Additional Information Resources:

Visit the following Web sites for more information on municipal and hazardous waste combustion and solid waste:

- U.S. Environmental Protection Agency (EPA): < www.epa.gov >
- U.S. EPA, Office of Solid Waste site on combustion: < www.epa.gov/epaoswer/non-hw/muncpl/disposal.htm >
- U.S. EPA, Office of Solid Waste site on hazardous combustion: < www.epa.gov/epaoswer/hazwaste/combust >

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